QUONDONG STATION, SOUTH AUSTRALIA: A FIELD CONTEXT FOR APPLIED RANGELAND RESEARCH

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SUMMARY

Sheep stations are the administrative units of the arid zone pastoral industry in southern South Australia. Their general nature, history and present circumstances are given, with particular regard for the native vegetation upon which their productivity depends, by using Quondong Station as an example. A study of the pastures of Quondong Station is presented, intended as a general field context to which research results may be related.

The flora of Quondong Station is listed. The native pastures are classified initially into four main groups, and are then cross classified on other features. Results are summarised in map form.

INTRODUCTION

In recent years concerted efforts have been directed towards ecological problems associated with the arid zone pastoral industry in South Australia. Much of the research is still in progress, but some is already published (Lange, 1969; Barker and Lange, 1969a). Such papers are specialised, and it is necessary to describe the field context within which specialised advances must be interpreted.

When sheep were introduced to arid Australia in the nineteenth century, their impact on the native shrubs was both sudden and disastrous. For example, Dixon (1880) and Woolls (1882) describe the destruction of saltbush after only a few decades of grazing in western New South Wales. Arid zone shrubs are slow growing, long lived plants adapted to low rainfalls and slow nutrient cycling. As such, they are quite different from kinds of plants that evolved under intensive grazing by ungulates. While climatic changes can gradually degrade arid zone vegetation for periods, the effect of hooved grazing animals on these vulnerable populations has had an inordinately destructive effect for such a short time span.

Pioneers were concerned with expansion and development in the short term, rather than conservation in the long term. This attitude can be understood when one recalls the colonists' ignorance about the Australian environment (Meinig, 1963).

At the present time, disregard for long term conservation can no longer be tolerated. It is imperative for the future of this State that the consequences of the pastoral industry be examined. The type of resource being used by the pastoral industry is described by reference to a single administrative unit, Quondong Station, where grazing has been more or less continuous since 1873. The situation here is similar to that on many sheep stations in this and other States; boundary fences cut across different vegetation, rock and soil types, and paddock size and shape is determined by the disposition of a limited number of stock water points, often having little relation to use of different pasture types. Under such conditions it is inevitable that, given free range over several square miles, stock will utilise and, in extreme cases, degrade certain types of vegetation more than others.

In addition to the description of the current situation on Quondong Station, the history of the area is outlined to indicate how historical factors may have had an effect on the present pasture pattern.

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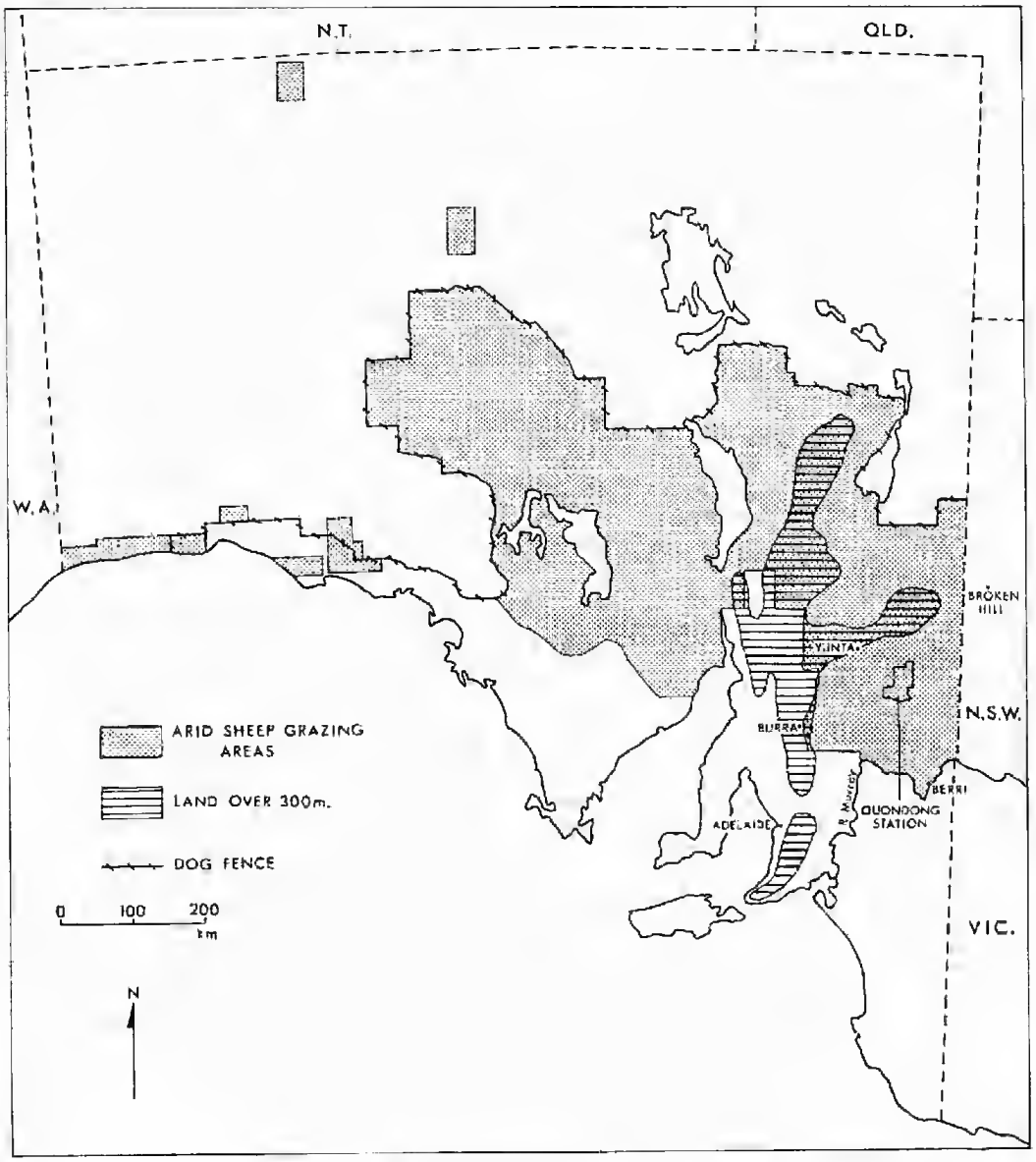

Fig. 1. Locality diagram.

SITUATION AND ENVIRONMENT

Quondong Station, covering an area of approximately 830 sq km, lies in the northern part of the Murray basin, south east of the Olary Spur, and almost equidistant between Burra and Broken Hill (Fig. 1). The over-riding climatic feature of this area is the low rainfall, the average for the period 1955-1968 being 180 mm (Table 1). The occurrence of rain is most erratic, more so, for instance, than in the coastal arid areas of the State (Commonwealth Bureau of Meteorology, 1961). Although the figures are variable, it appears that on average most rain is received in May and least in October.

TABLE 1
Rainfall at Quondong in mm
(by courtesy of the Pastoral Board)

	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1955	0·0	87·1	44·5	7·9	63·5	38·1	1·0	21·1	28·2	6·9	16·8	1·0	316·1
1956	0·0	0·0	62·0	19·6	33·0	16·0	37·3	4·3	19·8	9·7	13·5	0·0	215·2
1957	0·0	64·0	5·1	0·0	4·3	68·6	1·0	17·8	4·6	16·3	3·8	24·4	209·9
1958													
1959	1·3	13·0	23·6	0·0	11·9	0·0	14·2	7·9	4·3	28·2	0·0	8·4	112·8
1960	4·3	7·1	5·8	13·5	19·1	3·3	38·6	14·2	28·7	0·0	35·3	0·0	169·9
1961	0·0	11·9	1·3	27·7	5·6	0·0	6·6	12·5	17·0	1·3	64·8	29·2	177·9
1962	59·2	0·0	22·4	0·0	32·5	6·6	2·3	15·8	0·0	7·9	0·0	70·9	217·6
1963	39·6	0·0	0·8	22·4	45·2	41·7	21·8	16·8	0·0	12·7	2·5	11·7	215·7
1964	10·8	0·0	0·0	12·2	7·4	5·3	0·0	15·2	81·5	0·8	1·8	18·0	153·0
1965	0·0	—	—	0·0	3·8	13·2	15·5	13·7	16·8	0·0	7·1	27·2	97·3
1966	8·1	19·8	8·1	0·0	16·0	11·7	7·1	0·0	11·9	9·1	15·2	44·2	151·2
1967	8·1	36·3	4·8	0·0	4·1	2·8	2·8	16·8	6·1	0·0	0·0	0·0	81·8
1968	61·0	9·9	8·4	27·2	27·2	26·7	30·7	15·2	0·0	5·3	0·0	6·4	218·0
Mean	14·8	18·5	14·5	10·0	21·5	18·0	13·7	13·2	16·9	7·6	12·4	18·6	179·7

Records of wind direction are available for Yunta and these display conditions generally applicable to the plains lying east. During the warmer months the prevailing winds are from the southerly quarter, whereas in winter, winds are more frequent from the north west (Table 2).

TABLE 2
% Frequency of Wind Direction at Yunta at 900 hr
(by courtesy of the Bureau of Meteorology)

	YUNTA 1962-63											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
N	3	9	3	2	1	7	2	3	7	3	10	12
NE	14	7	2	5	10	8	3	3	3	10	17	7
E	2	1	0	2	0	0	2	0	1	0	2	0
SE	45	54	54	30	20	2	8	11	27	34	24	51
S	0	0	3	3	5	0	2	3	2	3	7	6
SW	13	18	17	25	20	17	18	18	27	24	26	12
W	2	0	0	0	5	5	3	8	5	3	0	0
NW	16	9	13	14	24	32	38	36	25	18	12	7
CALMS	5	2	8	19	15	29	24	18	3	5	2	5

Temperature data are shown in Table 3; the hottest months, January and February, achieve maxima of 32°C and the coolest months, June and July, 16°C and 14°C respectively. Extreme maxima and minima indicate the range of temperature which can be experienced by the region.

Such meagre meteorological information is typical for most sheep stations.

The geology of the area is imperfectly known (O'Driscoll, 1960; Ludbrook, 1961). Proterozoic and Palaeozoic basement rocks outcrop in the Mount Lofty Ranges and the Olary Spur forming a rim to the north of the Murray Basin. Quondong is about 52 km to the south-east of this outcrop and is situated on the

TABLE 3
Temperature in °C for Yunta
(by courtesy of the Bureau of Meteorology)

YUNTA

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Av. Max.	32·2	32·2	28·0	23·3	19·4	16·1	14·1	16·4	18·9	22·8	28·0	28·9
Av. Min.	14·1	14·4	12·0	8·3	5·6	3·3	2·8	4·2	5·0	8·3	11·2	12·2
Av. Mean	23·3	23·3	20·0	16·1	12·5	10·0	8·3	10·0	12·2	15·6	19·7	20·6
Extreme Max. 1951-65	46·1	43·3	40·6	33·9	27·8	23·9	22·8	28·3	98·0	40·0	42·2	43·9
Date	2/'60	28/'65	18/'65	2/'54	1/'58	19/'60	27/'60	11/'59	29/'65	20/'65	30/'62	19/'65
Extreme Min. 1951-65	6·7	4·4	1·3	1·1	−3·9	−6·7	−6·7	−5·0	−3·1	1·0	1·1	1·8
Date	1/'56	29/'58	22/'56	15/'63	24/'57	17/'59	9+10/'59	8/'62	27/'53	4/'53	3/'65	11/'52

infill material of the Basin, consisting of Tertiary and post-Tertiary littoral, marine and freshwater sediments, which in turn have been overlain by Recent aeolian deposits (O'Driscoll, 1960; Firman, 1965). This lack of geological information is not general, however, and for sheep stations situated where there are major rock outcrops, the information available is as good as that for the wetter parts of the State.

There is little detail in the literature concerning the relief of the area and the following new observations are presented. The general elevation falls 78 m in a south-easterly direction from the north of Ki-Ki Paddock, to the south-east corner of Drayton Paddock. Topographically the station may be divided into two regions north and south of a line which joins points A and B in Fig. 2. The principal ridges and drainage lines also shown in Fig. 2 have heights relative to each other varying between 1 m and 7 m.

To the north, the country is a gently undulating outwash plain of the Olary Spur, traversed by broad ill-defined watercourses or washes, the intervening areas being occupied by low calcareous ridges and Recent sand dunes. There are two main drainage systems in this region; one flows from north to south in Record, Sixty, Sergeant's, Well, Ki-Ki and Eighty paddocks and the other flows from west to east through Sergeant's and Swamp paddocks. The two systems mingle and lose their identity in George's and the Boundary paddocks. Only in the watercourse running through Ki-Ki and Eighty paddocks has gully erosion proceeded to the extent that parts of it could be regarded as a creek, with banks and a flat sandy bed (Pl. 1a). It is probable that this has occurred subsequent to sheep being depastured in the area, as a result of increased run-off due to compaction. This phenomenon has been observed elsewhere (Jackson, 1958).

The ridges, which are old dunes, have solonised soils, containing a high proportion of calcium carbonate both in the A horizon and in the lower layers, where nodular or massive calcrete occurs. This soil type is classified as Gc1. 12, according to the Factual Key (Northcote, 1965). The occurrence of polygonal patterned ground in these soils has been reported previously (Barker and Lange, 1969b).

South of the line A—B the ridges and dunes are more numerous and the broad alluvial expanses of watercourses are absent. The drainage lines are relatively small and are radial, draining into claypans and other low-lying areas.

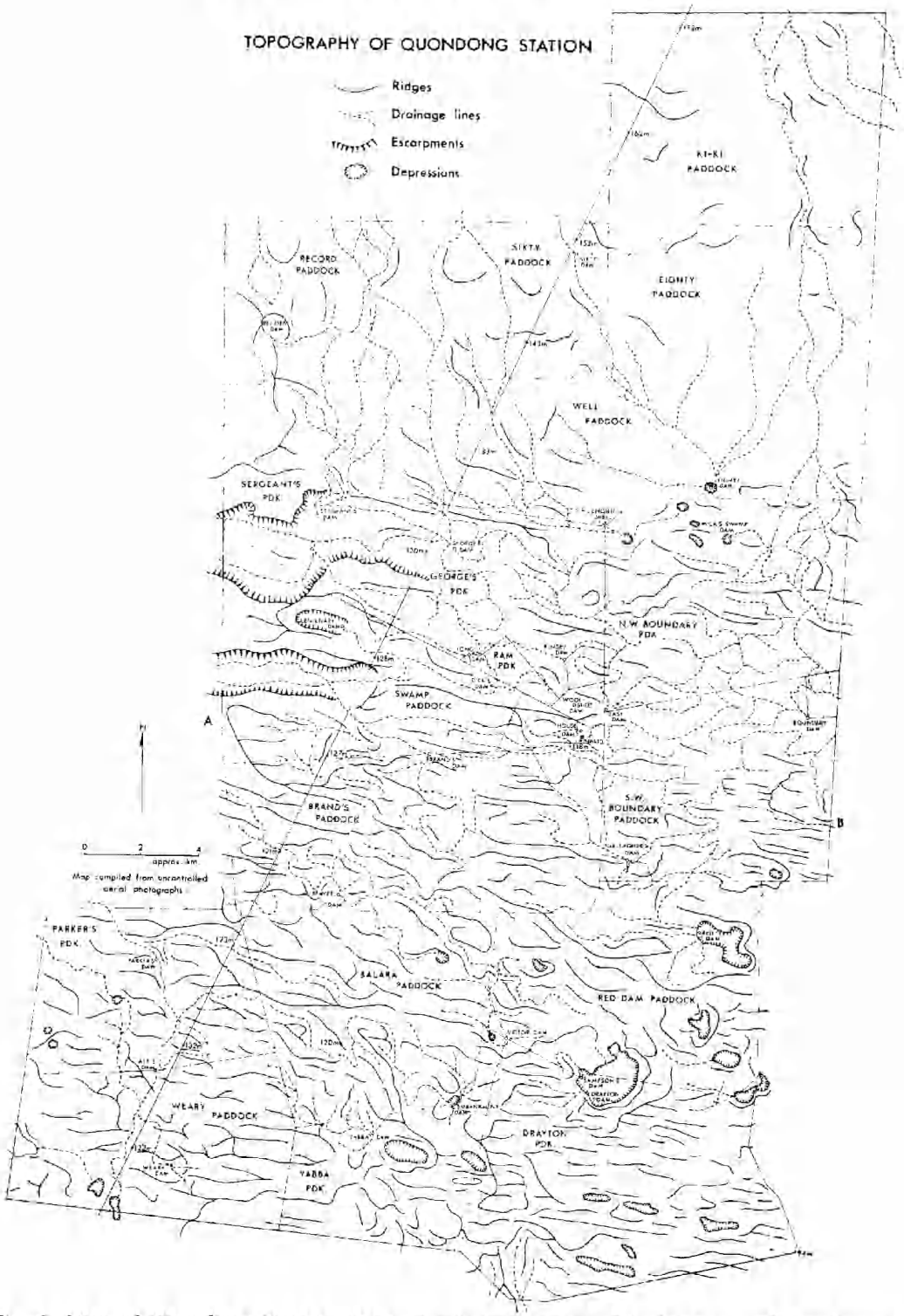

Fig. 2. Map of Quondong Station, showing principal topographic features and bench mark heights.

Some of the claypans have lunettes along their eastern margins. These may be an indication of a higher rainfall regime in the Recent past, as lunettes are apparently formed by a combination of wave action on lake shores during wet winter months and deflation from dry lake beds during the summer (Campbell, 1968). The current rainfall would be insufficient for water to lie in the Quondong claypans for any length of time.

The far south east of the station is occupied by a continuous area (some 25-30 sq km) of deep sandy dunes of Recent aeolian origin, oriented in an east-west direction. They can be recognised from the vegetation map by the occurrence of mallee; isolated sand dunes appear as far north as the Well paddock. These have soils classified as Uc5. 11.

Descriptions by O'Driscoll (1960) of the hydrology of the north of the Murray Basin are based on information from a few bores. The salinities of the fossil waters examined on Quondong are too high to allow for their use as stock water. All stock water is, therefore, derived from surface run-off stored in earth dams. The position of these in relation to the topography is shown in Fig. 2. All the dams are watering points for stock, and some of their water is piped to troughs in parts of the station which would otherwise be ungrazed.

The preceding account emphasises that a sheep station is not homogeneous in terms of landscape. Design of experiments in such a variable situation is thus difficult; also, extrapolation of findings from one region to another must be at the level of principal rather than detail.

VEGETATION

Over a period of one year, March 1967—April 1968, plant collections were made on Quondong. These collections, consisting of some 150 species, are now housed in the State Herbarium of South Australia. Subsequent experience on other stations with a herbaceous rather than a shrub vegetation has shown that plant collections often cannot be completed for several years.

The map at the end of this paper assembles and displays the outcome of the work upon which this paper is based. Sixty extensive ground traverses were needed to rectify adequately an initial interpretation based on aerial photographs. The classification thought best suited for analysis of the system was one using character trees first, then cross-classifying successively in terms of character shrubs, then herbaceous components. This kind of classification avoids the necessity to draw discrete boundaries as between two mutually exclusive classes, and permits mapping which expresses gradients of change.

Details concerning the map are given with the explanatory legend accompanying the map.

Compared with some stations the broad vegetation pattern is simple on account of the comparative geologic and topographic uniformity. There are four principal vegetation types. These are (I) *Casuarina cristata* (black oak) woodland (II) Mallee (III) *Callitris columellaris* woodland (IV) *Acacia aneura* (mulga) woodland. In addition, section (V) includes a miscellany of local but distinctive vegetation types characteristic of water-collecting areas other than the major watercourses or washes.

(I) *Casuarina cristata* (black oak) woodland, found on the old calcareous dune ridges north and south of the line A—B, occupies by far the greatest area of the station and is extremely dense in parts, particularly in the south. Although many groves of this tree are dead, especially in George's paddock, it is regenerating freely by means of suckers all over the station, even in apparently dead stands (Pl. 1b). This is of interest as workers in other parts of the State (Hall, Specht and Eardley, 1964; R. M. Purdie—personal communication) imply that

under heavy stocking or in times of drought *Casuarina* suckers are grazed down before they can reach maturity.

Other tree species found commonly throughout this woodland are *Myoporum platycarpum*, freely regenerating from seed (Pl. 1c), contrary to observations by Hall *et al.* at Koonamore, and *Heterodendrum oleaefolium*, the regenerating suckers of which are grazed down as in other parts of the State (Hall *et al.*, 1964; R. M. Purdie—personal communication).

Eremophila longifolia (emu bush), *Acacia osicaldii*, *Pittosporum phylliraeoides* (native willow, apricot), and *Santalum acuminatum* (quondong) are rather less common.

The shrub layer consists principally of *Kochia sedifolia* (bluebush) with *K. excavata* var. *trichoptera* and *Bassia diacantha*. On the tops of the calcareous ridges there is often very little else, but other shrubs fairly common locally are *Ptilotus obovatus*, *Olearia muelleri*, *Scaevola spinescens*, *Cratystylis conocephala*, *Cassia nemophila* var. *nemophila*, *C. nemophila* var. *coriacea*, *Acacia colletioides* and *Templetonia egena* (desert broombush), with *Kochia brevifolia*, *K. georgei*, *K. astrotricha*, *Lycium australe* (boxthorn), *Nitraria schoberi* (nitrebush), *Eremophila glabra* (tar bush), *E. scoparia* and *Zygophyllum aurantiacum* less common. *C. nemophila* var. *zygophylla*, *C. nemophila* var. *platypoda*, *Acacia hakeoides* and *Ptilotus atriplicifolius* are rare.

Atriplex vesicaria (bladder saltbush) occurs only in small quantities; an apparently isolated area in Ki-Ki paddock is the southernmost extension of saltbush from the floodplains of the Olary Spur on the adjacent Lilydale Station. Elsewhere on Quondong, *A. vesicaria* is associated with low lying areas in the south.

Kochia pyramidata, recognised as a symptom of degraded arid pastures in the north-west of the State (Jessup, 1948; Correll, 1967), does not occur extensively on Quondong Station.

Rhagodia spinescens var. *deltophylla*, *Rh. nutans* and *Enchylaena tomentosa* are found throughout the *Casuarina* woodland, but mainly under trees and in drainage lines.

(II) The mallees, *Eucalyptus oleosa* and *E. gracilis* on the dunes in Drayton paddock, a northern extension of the Murray Mallee, have a sparse shrub understorey. *Triodia irritans* (porcupine grass) provides most of the ground cover; further north there is less porcupine grass and shrubs are present, including *Chenopodium desertorum*, *Grevillea huegelii*, *Hakea leucoptera*, *Olearia pimelioides*, *Kochia triptera* var. *erioclada* and *K. sedifolia*, and the herb *Boerhavia diffusa*. In places the mallee intergrades with dunes carrying *Casuarina cristata* and *Hakea leucoptera*, with *Kochia tomentosa* and *K. triptera* var. *erioclada*.

(III) In two small areas of the station sand dunes are occupied by *Callitris columellaris*, with *Hakea leucoptera*, *Kochia brevifolia*, *K. triptera* var. *erioclada* and the grass *Eragrostis laniflora* in the understorey.

(IV) *Acacia aneura* (mulga) stands are in the drainage lines and watercourses which dissect the *Casuarina* woodland in the northern half of the station. Timber is much less dense in these areas and in the well defined watercourse of Ki-Ki and Eighty paddocks includes *Acacia victoriae* as well as other tree species mentioned in the description of the black oak woodland. Shrubs and forbs in these areas are

Eremophila maculata (native fuchsia)
E. oppositifolia
Bassia paradoxa
Atriplex limbata
A. spongiosa
A. angulata
A. lindleyi

A. acutibractea
Solanum esuriale
Acacia burkittii
Cassia nemophila var. *nemophila*
C. nemophila var. *coriacea*
Swainsonia viridis
Ixiolaena leptolepis
Erodiophyllum elderi
(Koonamore daisy)
Senecio magnificus
Pterocaulon sphacelatum
Hibiscus krichauffianus
H. farragei
Sida intricata
S. corrugata
S. corrugata var. *angustifolia*

Herbaceous plants found in watercourses and wash areas are
Stipa nitida
Cymbopogon exaltatus
Eragrostis dielsti
E. setifolia
Chloris acicularis
Enneapogon avenaceous
E. cylindricus
Panicum effusum
Danthonia sp.
Vittadinia triloba
Brachyscome ciliaris
Helipterum floribundum
Calotis hispidula
Nicotiana goodspeedii
Convolvulus erubescens
Goodenia subintegra
Chenopodium pumilio
Arabidella trisecta
Malvastrum spicatum
Morgania glabra

(V) Although many of the above watercourse species occur along tracks, in sinkholes, drains and in the vicinity of dams, others are quite specific to sinkholes and similar small depressions—
Gilesia biniflora
Alyssum linifolium
Teucrium racemosum
Euphorbia eremophila
Oxalis corniculata
Marsilea drummondii (nardoo)
Eriochlamys behrii
Centipeda thespidioides
Abutilon malvifolium

while some are specific to areas around dams and the drains leading into them, for example,
Centaurium spicatum
Glinus lotoides
Gnaphalium luteo-album
Tetragonia tetragonoides
(native spinach)
Portulaca oleracea
Verbena officinalis
Minuria leptophylla
Atriplex cardleyi
A. spongiosa
Babbagia acroptera
Bassia brachyptera
Tribulus terrestris
Plantago varia.

In addition, alien weeds are to be found only in watercourses and other water-collecting areas:
Xanthium spinosum
(Bathurst burr)
Salvia lanigera
Inula graveolens (stinkwort)
Nicotiana glauca (tobacco bush)
Centaurea melitensis
Citrullus lanatus
(bitter melon)
Cucumis myriocarpus
(paddy melon)
Asphodelus fistulosus
(wild onion)
Sida leprosa var. *hederacea*
Diplotaxis tenuifolia
Heliotropium supinum
H. europaeum
Polygonum aviculare
Chenopodium murale.

These are obviously very dependent on additional water for survival and are unlikely to spread to drier sites.

Swamps near Centenary Dam and Mick's Swamp Dam are characterised by *Muehlenbeckia cunninghamii* (lignum), *Chenopodium nitrariaceum* and *Eragrostis australasica* (canegrass), while parts of the southern clay pans have *Disphyma australe* (pigface) and *Pachycornia* sp. growing on them.

GRAZING HISTORY

Early pastoralists in South Australia relied upon supplies of natural surface water for stock, with the result that grazing in arid country began in the Flinders Ranges and Olary Spur. The northern part of the Murray Basin was without surface water (S. Aust. Parl. Paper No. 57, 1865-66), so this region was not opened up until the 1870's.

The present Quondong Station was originally three administrative units; a run known as Quondong Vale (including Brands paddock, S.W. Boundary paddock and all paddocks to the north of these), part of the Drayton Run (now Red Dam and Drayton paddocks) and part of the Pine Valley Run (Balara, Yabba, Weary, and Parker's paddocks).

Although the lease of Quondong Vale was first acquired in 1873, it is unlikely that any grazing occurred during the first few years as there would be no permanent water until 1876 when a Woolshed Dam in the south of George's paddock was dug. A further seven dams had been dug by 1880 and eight more and the Engine Well were complete by 1890; if sufficient rain had fallen during this period to fill the dams, then considerable areas would have become available for grazing.

The watercourse or wash country close to the homestead in George's, Swamp, Brand's and the Boundary paddocks, which were fenced prior to 1884, was probably the only area in constant use for shepherding sheep up to 1896. The surveyor described this area as "fair pasture; open country covered with various bushes and bluebush plains with a little grass; greater part heavily timbered with black oak etc." There is evidence that in the country north of this (now Sixty, Record, Eighty and Ki-Ki paddocks) the lessee had difficulty in establishing dams; also as the vegetation was described as heavily timbered with only a few open bluebush, plains, it was probably only lightly grazed, if at all.

It is apparent from correspondence with the Surveyor General's Office that the lessee had other problems. By 1890 the north of the Murray Basin was overrun by rabbits and dingoes (see also S. Aust. Parl. Paper No. 33, 1891) and by 1892 was drought stricken. No rain had been received for twelve months and leases to the south had been abandoned. Although the lessee said he would not restock the country as his lease was about to expire in 1894, he continued to run sheep until 1896, when he finally abandoned the country. He had 340 sheep watering on the Engine Well at that time in a vain attempt to convince the Government Analyst that the water was not too saline for stock. It may be this event which accounts for the effect seen in Pl. 1d where close to the Engine Well, George's paddock is denuded of bluebush.

Less is known about the Drayton and Pine Valley runs; as these two leases were taken out together in 1874 by the same person they were presumably run as a single unit. This area corresponds to the southern topographic region. The surveyor described it as "Poor pasture; undulating; light red sandy loam with occasional clay flats, limestone rubble on the surface. . . . dense black oak, mallee, sandalwood, and various bushes, undergrowth and saltbush." Six dams and a well were dug by 1890. Embankment Dam was the first and shepherding was certainly

carried on there in the nineteenth century. Weary Dam, dug in 1881, was used to water bullock teams crossing from New South Wales to Burra. As the pasture was assessed as being poorer than that further north, sheep on the Drayton-Pine Valley Run would have been more susceptible to the drought prevailing by 1891, leading to the abandonment of parts of it only 17 years after the lease was first taken up.

It seems reasonable to assume that the northern part of Quondong Station (Quondong Vale) was more heavily grazed during the nineteenth century than the southern part (Drayton—Pine Valley). Whatever the actual stock numbers may have been in these two areas, it seems certain from Goyder's remarks (S. Aust. Parl. Paper No. 82, 1867) that the practice of shepherding was far more destructive than the present one of allowing sheep to range freely within paddocks.

Between 1901 and 1909 one lessee acquired the leases described above now comprising Quondong Station; since then six more dams have been dug and more paddocks fenced, thus allowing more extensive use of pasture. The regular use of the country for sheep grazing probably dates from about 1910. Information in the Department of Lands indicates that the heavier use of the watercourse country to the north of the homestead continued for at least some of the past 60 years, the Drayton—Pine Valley section being referred to on one occasion as showing no sign of erosion or overstocking, as water supplies were too small to permit that, whereas there are implications that some of the watercourse paddocks had been overstocked.

Historical records for other stations are certainly more complete, particularly where the lease has been held by one family for several generations. Although the present manager of Quondong is interested in the station's history, the lease has been previously held by several others and records have been mislaid or destroyed. It would be of immense value in long term assessment of arid pasture conditions if all station records, including rainfall data, numbers of stock carried, photographs, could be maintained in Pastoral Archives.

DISCUSSION

Some of the effects of using arid vegetation as sheep pasture are beginning to be understood. The break up of the soil surface and destruction of a lichen crust, immediately lays the soil open to erosion by wind and water even where vegetation remains. Nutrients are removed with the top layers of soil. It has been suggested by Correll (1967) that the loss of nitrogen in this way has encouraged the change from *Kochia sedifolia* to *K. pyramidata* shrubland north-west of Port Augusta. While the surface layers may be pulverised, lower soil layers round water points and along sheep pads become highly compacted, promoting run-off, and allowing subsequent storage of water in dams, which would otherwise enter the soil (Jackson, 1958).

Such physical changes as these are clear within a short period of time and are now, therefore, predictable for all sheep grazing areas. However, the longevity of arid zone plants (Correll and Lange, 1966; R. M. Purdie—personal communication) means that changes in vegetation (apart from its complete removal in overstocked situations) will be much slower to appear, and consequently with our present state of knowledge, much less predictable. Not only does arid vegetation vary all over the State according to environmental differences, but even on one station the vegetation pattern will differ from paddock to paddock and within individual paddocks. The position of water points in paddocks will obviously affect the utilisation of these different pasture types, for it is well known that sheep degrade vegetation close to water before that in other parts of

paddocks (Osborn, Wood and Paltridge, 1932; Barker and Lange, 1969a). Sheep grazing habits are not yet fully understood, but general observations indicate that sheep preferentially graze watercourse vegetation and tend to graze into the wind along the southern edges of paddocks.

The uniform use of pasture is made very difficult in areas where paddock size and shape is strictly controlled (as at Quondong) by the number of suitable catchments for dams and the water-holding capacity of the substrates. In other arid areas of South Australia plentiful bore water and piped river water allow strategic positioning of troughs in small paddocks, thus encouraging stock to utilise pasture they might otherwise ignore.

The descriptions and comparisons made in this paper exemplify the multivariate situation which arid rangeland ecologists have to understand before changes in the vegetation can be attributed to stocking. The overall vegetation pattern on Quondong Station is similar to that in the immediately surrounding areas of the Murray Basin, but differs from that found elsewhere in arid South Australia. It must, therefore, be understood that plants which may indicate degeneration in one part of the State do not necessarily indicate degeneration in other areas. This raises an important point. Results or observations gained from one location in the arid zone must not be extrapolated injudiciously. For example, comments made by Hall, Specht and Eardley (1964) on the regeneration of *Casuarina cristata* and *Myoporum platycarpum* at Koonamore, and by Jessup (1948) on the spread of *Kochia pyramidata* in overstocked situations in the north west, are at variance with observations made on Quondong. Generalisations made on the basis of particular results have introduced a great number of misleading statements into the literature.

A modern approach to the solution of management problems associated with natural ecological systems like these native arid pastures is to use simulation studies. These depend on the definition of parameters which describe the various aspects of the total system. At present it is difficult to see how precise parameters can be derived for such extremely variable vegetation.

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